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foot, at a speed of one mile per hour ; increasing, for greater velocities, in a ratio considerably higher than the square of the velocity.

The author concludes with some observations on the results lately obtained in Scotland, where great velocities were given to boats moving on canals, without a proportional increase of resistance.

The reading of a paper, entitled, "Researches on the Arseniates, Phosphates, and Modifications of Phosphoric Acid," by Thomas Graham, Esq., M.A., F.R.S.E., Lecturer on Chemistry in the Andersonian Institution of Glasgow; communicated by Edward Turner, M.D., F.R.S.—was commenced.

June 13, 1833.

HIS ROYAL HIGHNESS THE DUKE OF SUSSEX, K.G.,
President, in the Chair.

Mr. Graham's paper was resumed and concluded.

The tendency of the arsenic and phosphoric acids to form sub-sesquisalts with the oxides of silver and lead is well known ; corresponding salts with alkaline bases also exist. The author describes the method of forming the subarsenate and subphosphate of soda, and their properties ; and shows that they are sub-sesquisalts, containing one proportion and a half of base to one of acid. They are the only known soluble salts of that constitution ; and it is remarkable, that the acid of the subphosphate of soda is not convertible into pyrophosphoric acid by the action of heat, like the acid of the common phosphate of soda. This may be explained on the hypothesis, that phosphoric acid, in contradistinction to pyrophosphoric acid, contains an atom of water, which stands in a basic relation to the acid, and which may be replaced by an atom of any of the usual bases. Hence also arises the disposition of phosphoric acid to form sub-sesquisalts ; for the common phosphate, used as a precipitant, exchanges its basic water for a fixed base ; and for this reason, likewise, phosphate of soda, or any neutral phosphate, cannot be made anhydrous without becoming a pyrophosphate ; but the subphosphates having an excess of base, may be anhydrous, as Stromeyer observed ; and indeed they are not convertible into pyrosalts. The acid formed by the combustion of phosphorus in air or oxygen, constitutes a third modification of phosphoric acid, distinguished by peculiar properties, and which, from the difference of its saturating power, in relation to that of the phosphoric and pyrophosphoric acid, the author considers as a *polymeric* phosphoric acid ;—a term lately applied by Berzelius to bodies of the same relative composition, but differing in their combining proportions.

The author devoted much time and attention to determine the quantity of water of combination in the foregoing subsalts ; but the result he obtained, namely 50.22 per cent., is not easily reconciled with our best data for atomic weights. It is, however, pretty nearly compatible with 23 or 24 atoms of water, according to Berzelius's weight of the atom of arsenic ; and if the latter estimate be correct, it is curious

that the subarseniate differs from the neutral arseniate, merely by the substitution of an atom of soda for an atom of water; for the latter salt contains 25 atoms of water.

The author's experiments on the composition of the subarseniate of soda,—the results being reduced to the hypothesis, that it contains 23 atoms of water,—represent it as formed, (per cent.) of arsenic acid, 27·69; soda, 22·55; water, 49·75. The subphosphate of soda was found to consist (per cent.) of subsesquiphosphate, 43·97; water, 56·03; the soda in the salt amounting to 24·87.

The author attempted to determine the quantity of phosphoric acid in this salt, by direct precipitation by nitrate of silver, but could not obtain rigorously accurate results; for the subphosphate of silver carried down with it a portion of the nitrate, which washing could not entirely separate. He likewise failed in his endeavours to obtain pure subphosphate and subarseniate of potash.

The subarseniate of barytes appeared, by a single experiment, to be composed, (per cent.) of arsenic acid, 32·06; barytes, 67·94: from which the salt would seem to contain an excess of base; for by theory, the subsesquiarseniate of barytes should be composed of, acid, 33·4; base, 66·6.

When solution of muriate of lime is poured into an excess of solution of phosphate of soda, or when phosphate of lime, dissolved in muriatic acid, is precipitated by ammonia, a gelatinous mass is formed, which has been called the subphosphate of lime of bones; the composition of which is singular, consisting, on the simplest view that can be taken of it, of 3 atoms of phosphoric acid, and 4 of lime. It was noticed by Berzelius.

The author thinks the anomalous composition of this salt may in some measure be explained by considering it as consisting of 1 atom of the neutral, and 2 atoms of the subsesquiphosphate. According to Berzelius, calcined ox-bones are composed of such a phosphate of lime, with a little carbonate of lime; but a doubt arises of the accuracy of this view, from the fact, that the presence of carbonic acid in the calcined phosphate of bones is no proof of the existence of that acid in the same, previous to calcination.

The earth of bones, after calcination at a high temperature, contains phosphoric, and not pyrophosphoric, acid; the excess of base preventing the transition.

The author's analysis of subarseniate of lead, formed by the gradual addition of solution of acetate of lead to solution of subarseniate of soda, afforded a striking confirmation of the atomic weight of arsenic, deduced by Berzelius from his analysis of arsenious acid by sulphur.

A paper was read, entitled, "Some Observations on the Structure of Shells, and on the Economy of Molluscous Animals." By John Edward Gray, Esq. F.R.S.

The author distinguishes two kinds of structure in shells; the one in which the calcareous matter is crystallized, composing what Mr. Hatchett has called the *porcellaneous structure*; and the other, in which it is deposited in grains intermixed with a large proportion of